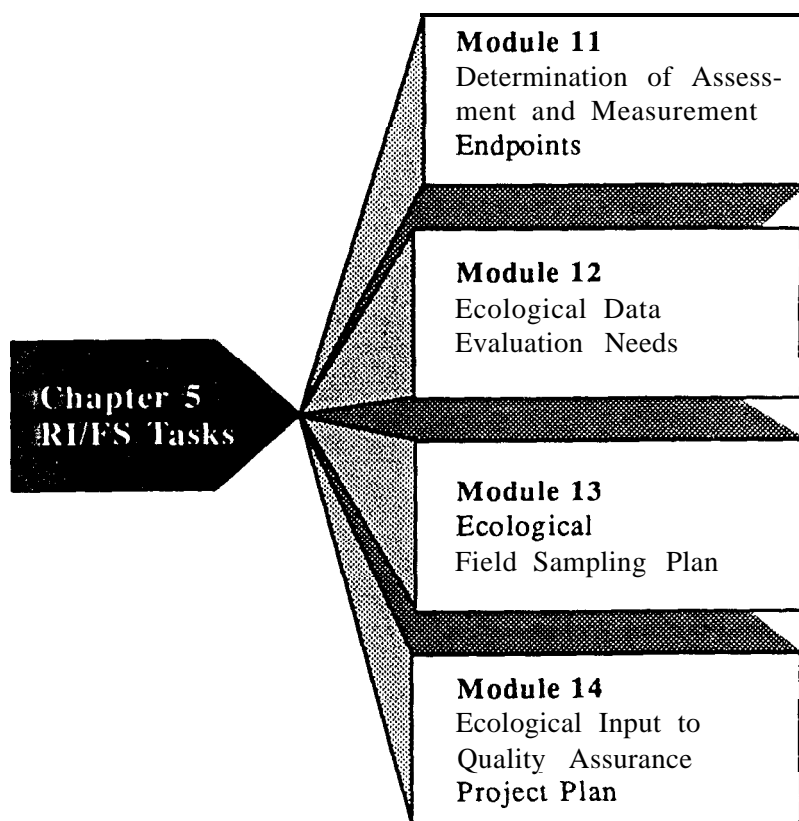


CHAPTER 5

RI/FS Tasks



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CHAPTER 5: RI/FS TASKS

The preliminary RI/FS work plan is prepared during the project planning phase, before remedial investigation activities are initiated. The ecological work plan should be prepared in parallel with the RI/FS plan and is a component of the overall RI/FS plan. Project ecologists must provide input to both plans. The EPA (1988a) provides guidance on the content and format of RI/FS work plans. Fourteen standard tasks are required for preparation of the RI/FS work plans.

The ecological work plan includes an ecological field sampling plan and a quality assurance project plan. In addition to task descriptions for planned field studies, the field sampling plan also includes task descriptions for laboratory toxicity testing and whole body or tissue analyses for fate and transport studies.

Ecological Data Objectives

Defining the ecological data objectives is often an interactive or phased process. These objectives must be consistent with the 14 overall RI/FS tasks (Table 5.1).

Preliminary ecological work plan tasks are implemented based on certain assumptions of contaminant locations, concentrations, potential exposure pathways, and receptor species. As preliminary data are obtained, sampling locations and strategies may change to more fully characterize the site and evaluate the current effects of chemical contaminants on biotic communities. To avoid redundancy, the ecological sampling and toxicity tasks should not be repetitive of site-specific fate and transport studies conducted in other RI/FS tasks undertaken to fully characterize the contamination.

Data evaluation needs should be defined when field sampling and laboratory tests are being planned. Two EPA publications (EPA 1987, 1989b) provide guidance of field sampling methods suitable for contaminated waste/hazardous substances sites. The ecological work plan also should define data evaluation methods and the approach in establishing assessment and measurement endpoints. When possible (i.e., when the site ecosystems are well characterized at the project outset), measurement and assessment endpoints should be included in the initial ecological work plan.

The ecological field sampling plan must include tasks to (1) characterize biotic communities of the site and reference areas when applicable, (2) evaluate current ecological contamination, (3) evaluate the ecological effects during implementation of various remediation options under consideration [NCP, Part 300.430(e)(a)(E)], and (4) allow comparisons of the postremediation ecosystems and project objectives for the intended land use.

TABLE 5.1 Standard Tasks Required for the Preparation of an RI/FS Work Plan

Task Number	Task Description
1	Project planning (project scoping)
2	Community relations
3	Field investigation
4	Sample analysis/validation
5	Data evaluation
6	Assessment of risk
7	Treatability study/pilot testing
8	Remedial investigation reports
9	Remedial alternatives
10	Detailed analysis of remedial alternatives
11	Feasibility study reports
12	Post RI/FS support
13	Enforcement support
14	Miscellaneous support

Source: EPA (1988a)

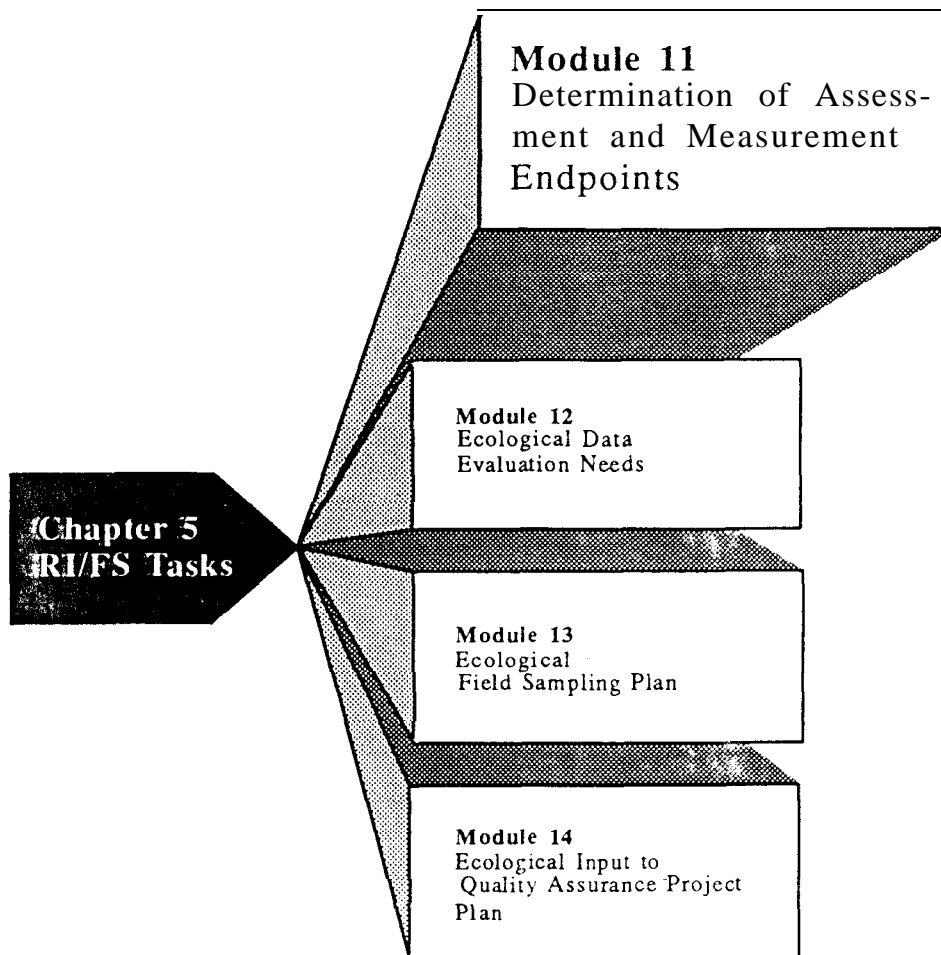
References

EPA, 1987. *A Compendium of Superfund Field Operations Methods*, report EPA/540/P-871001, U.S. Environmental Protection Agency, Washington, D.C.

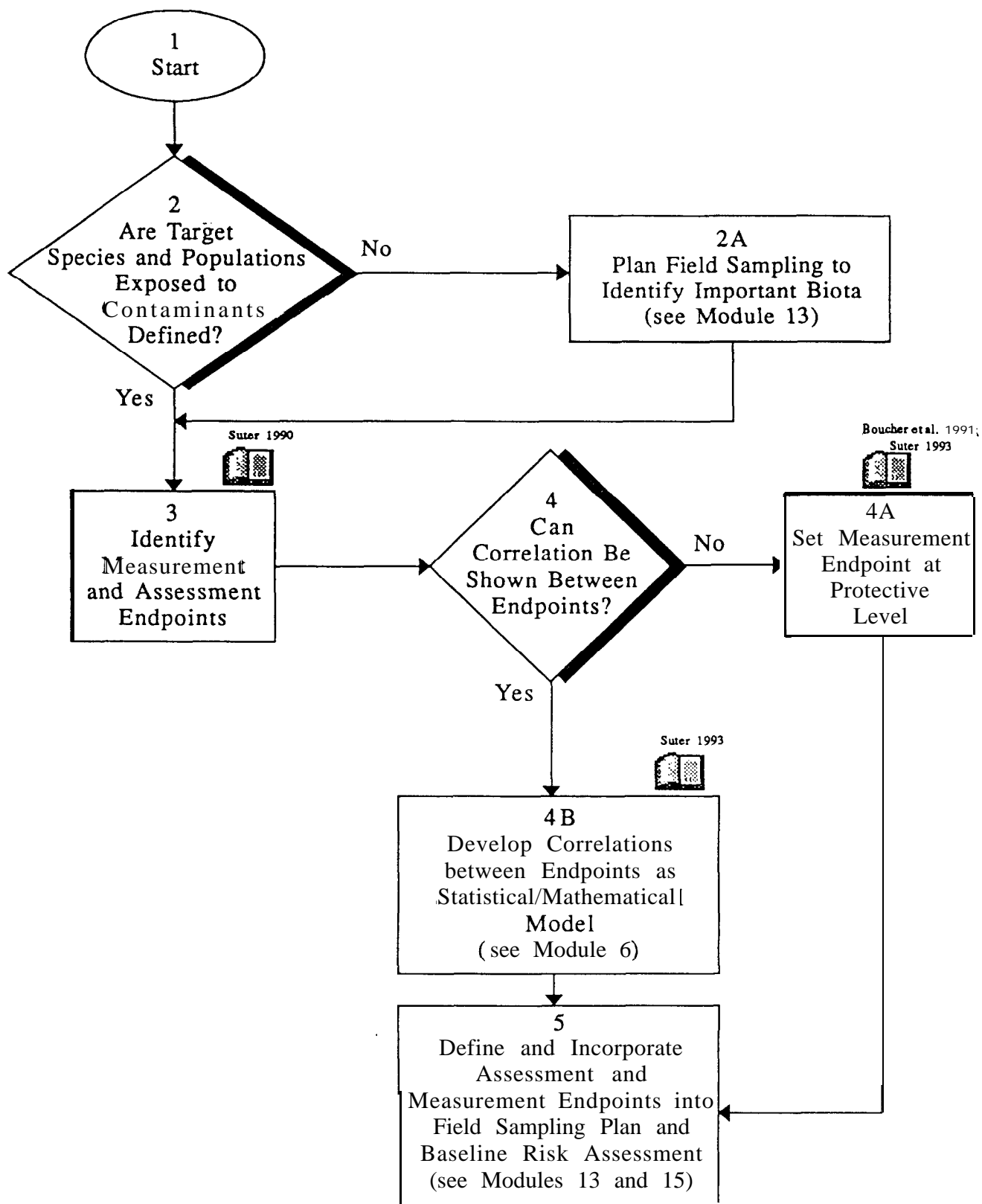
EPA, 1988a. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*, report EPA/540/G-89/004, OSWER Directive 9335.3-01, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989b. *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference*, report PB89-205967, U.S. Environmental Protection Agency, Washington, D.C.

MODULE 11:
**DETERMINATION OF ASSESSMENT AND
MEASUREMENT ENDPOINTS**



Module 11: Determination of Assessment and Measurement of Endpoints



MODULE 11: DETERMINATION OF ASSESSMENT AND MEASUREMENT ENDPOINTS

Step 1 Start.

Step 2, 2a Guidance on the assessment of impacts and measures to be monitored should be reviewed for relevance to the contaminated waste site requiring remedial action (EPA 1988a,b; 1989c). Target species of concern relative to contaminant exposure should be determined. Species selected for analysis should be important with respect to community structure and ecological function.

An *endpoint* has been defined as "a characteristic of an ecological component that may be affected by exposure to a stressor" (Suter 1990). A *stressor* can be considered a chemical, radiological, or physical hazard occurring at or near a contaminated site that can adversely effect resident or transient species. Stressors should be quantified and spatially defined in the site characterization phase of the RI/FS.

Step 3 Selection of endpoints may be a controversial issue among project ecologists and engineers. Schedule, budget, legal protection of receptor species, importance in determining severity of ecosystem contamination, and use of ecological data in answering remediation evaluation questions need to be considered when deciding on endpoints. The DOE ERPM and project ecologist should ultimately decide on endpoints when controversies occur. The project ecologist should identify appropriate endpoints justified on the basis of technical grounds. Suter (1993, pp. 50-51) identifies four steps for establishing appropriate endpoints based on technical considerations. The EPA (1989c) has provided information on the selection of assessment and measurement endpoints.

Setting Appropriate Endpoints

Tasks to set appropriate endpoints include (1) creating a matrix of sources of environmental contamination and ecosystem components potentially affected by the contaminants (ecosystem components are then scored on the basis of sensitivity to the hazardous substances and exposure intensity); (2) reviewing the literature to determine species sensitivity to chemical contaminants of analyses where stresses are regional in nature and impacts cannot be attributed to a point source contaminant such as a hazardous waste site; (3) identifying organisms most likely to be exposed to the contaminants based on determining ecological groups most susceptible and conducting a brief exposure assessment; and (4) determining indirect effects of the contaminant through use of diagrams or trees of causal linkages between the emissions and various environmental components.

Two types of endpoints should be established in project planning: assessment endpoints and measurement endpoints. The examples presented in the measurement and assessment endpoint text boxes are commonly utilized endpoints but should not be considered as all-inclusive. Some measurement and assessment endpoints are synonymous (e.g., population endpoint parameters). (**Appendix A, Table A-2.**)

Assessment endpoints are formal expressions of the actual environmental values to be protected. Examples include (1) population — extinction, abundance, yield/production, age/size class structure, and significant mortality; (2) community — market/sport value, recreational quality, and change to less useful/desired type; and (3) ecosystem — productive capability (EPA 1989b).

Step 4,4a,4b It may be possible to determine correlations between assessment and measurement endpoints with a mathematical model. For example, the decline in abundance in fish species reproductive rates in laboratory exposures to various contaminants can be compared to reproduction rate effects in zones of varying contaminant concentration in controlled field conditions. Comparisons may then be useful in determining risk-based cleanup criteria for soils, water, or sediments. As another example, the effects of various contaminant concentrations on reproductive potential and tissue concentrations in small mammals can be compared in laboratory ingestion studies to similar endpoints measured for small mammals collected at the CERCLA site and associated reference areas (EPA 1989b). These data, together with population density data, could be expressed in a mathematical model that correlates the two types of endpoints. Correlations between assessment and measurement endpoints and their use in setting cleanup criteria should be evaluated in consultation with the DOE

Measurement endpoints are quantitative expressions of an observed or measured effect of a hazard and must correspond to or predict assessment endpoints. They must be readily measured and appropriate for the exposure pathways, temporal dynamics of contaminant exposure, and scale for the site being evaluated. Examples of measurement endpoints at different hierarchical levels are (1) individual — death, growth, behavior, and tissue concentrations; (2) population — occurrence, abundance, age/size class structure, yield/production, and reproductive levels; (3) community — number of species present, species diversity, pollution indices, and community type; and (4) ecosystem — biomass, productivity, and nutrient dynamics. Good assessment endpoints should be readily measured, biologically important, and of value to society (EPA 1989b).

ERPM for developing overall remediation objectives and evaluating remediation alternatives. In cases where such correlations cannot be made, a level should be established that affords adequate protection to the most sensitive species or community types exposed to the contaminants of concern. The development of such “risk-based” levels are beyond the scope of this guidance document.

step 5 Attention to clear definition of assessment and measurement endpoints should be a subject for discussion among experts when designing the field sampling plan. The BTAG can provide useful information on selection of species and measurement endpoints from their experience with other hazardous waste sites. The ecological work plan described in Appendix A includes information on the process of setting endpoints at a Superfund site (**see Appendix A, Table A.2, Section A.3.1**).

References

Boucher, P.M., et al., 1991. *Ecological Exposure Assessment of a PCB-Contaminated Wetland in Massachusetts*, In: Proceedings of the 12th National Conference Hazardous Materials Control/Superfund Conference, Washington, D.C., Dec. 3-5, Hazardous Materials Control Research Institute, Greenbelt, Md., pp. 706-709.

EPA, 1988a. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*, report EPA/540/G-89/004, OSWER Directive 9335.3-01, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1988b. *Review of Ecological Risk Assessment Methods*, report EPA/230/10-88/041, U.S. Environmental Protection Agency, Washington, D.C.

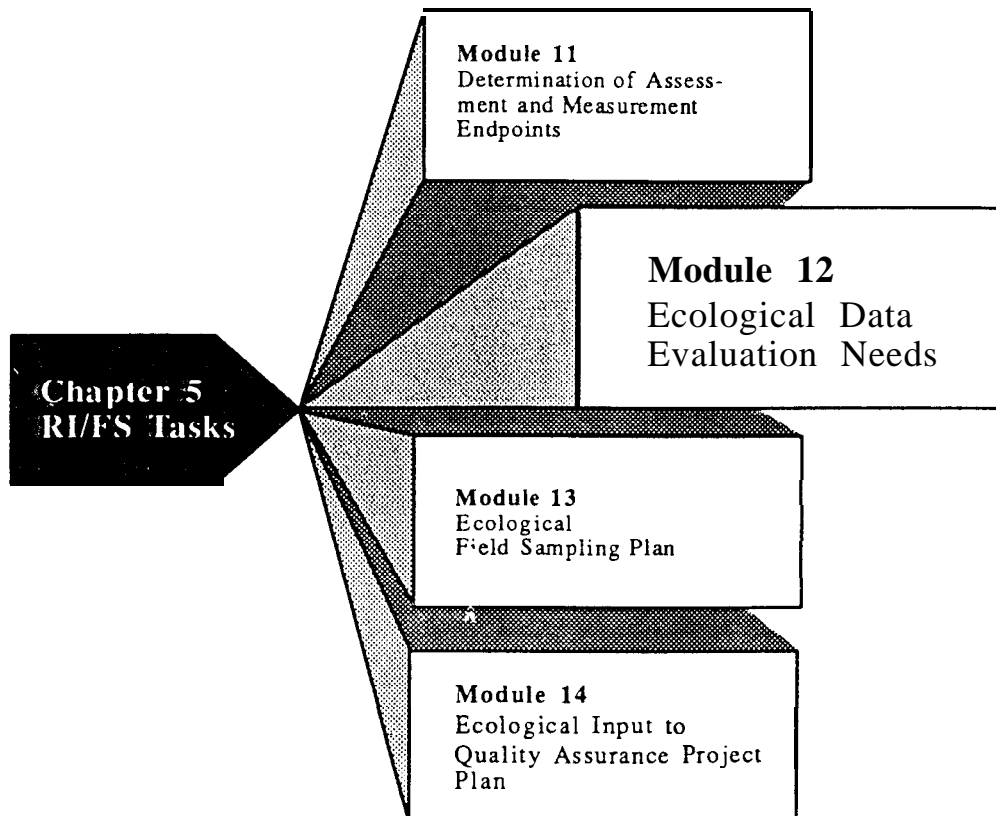
EPA, 1989b. *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference*, report PB89-205967, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989c. *Risk Assessment Guidance for Superfund — Vol. II, Environmental Evaluation Manual*, report EPA/540/89/001, U.S. Environmental Protection Agency, Washington, D.C.

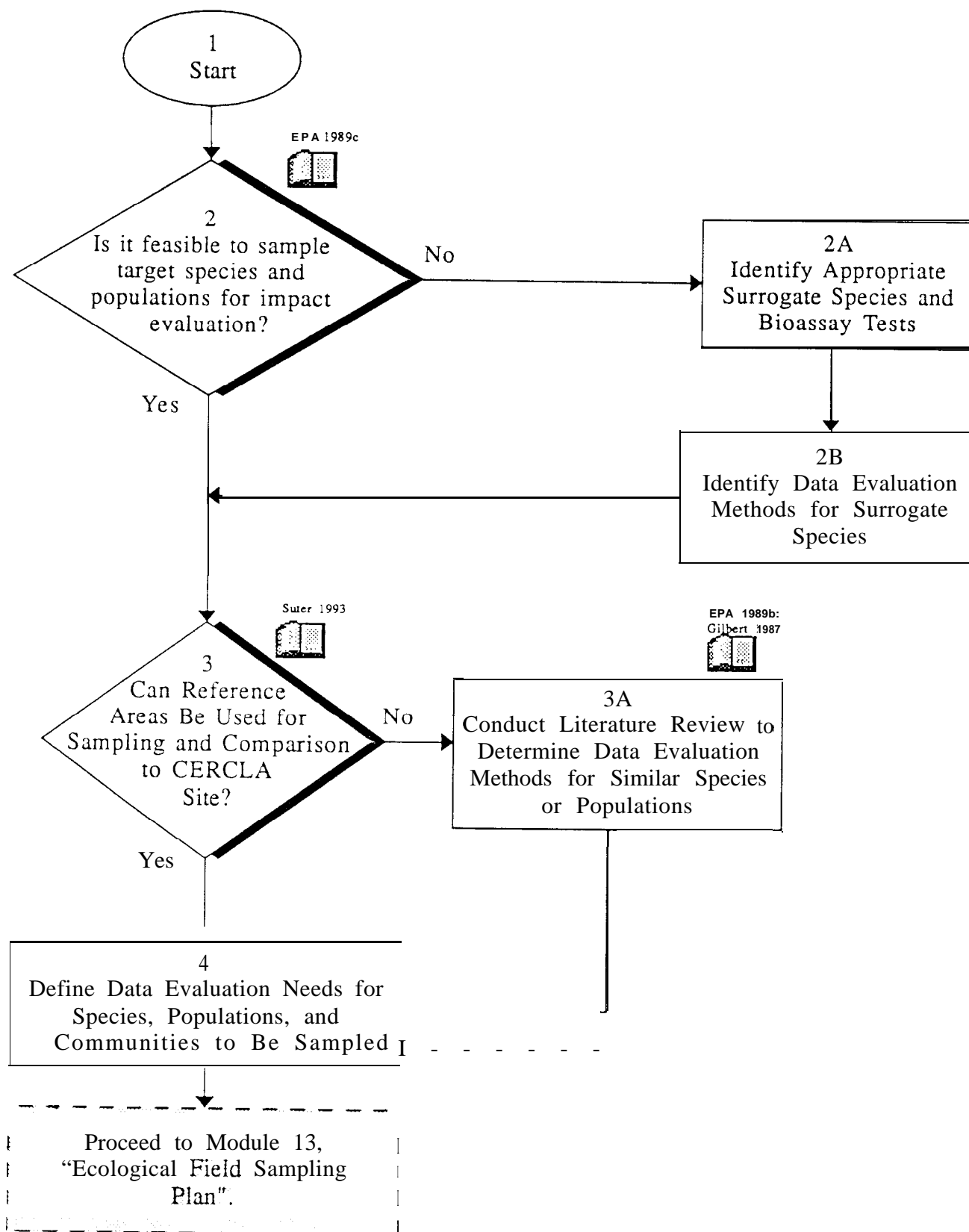
Suter, G.W., II, 1990. *Endpoints for Regional Ecological Risk Assessments*, Environmental Management, 14:9-23.

Suter, G.W., II, 1993. *Ecological Risk Assessment*. Lewis Publishers, Chelsea, Mich., pp. 1-538.

MODULE 12:
ECOLOGICAL DATA EVALUATION NEEDS



Module 12: Ecological Data Evaluation Needs



MODULE 12: ECOLOGICAL DATA EVALUATION NEEDS

Step 1 Start.

Step 2 The site may not be conducive to field sampling for the following reasons: (1) the contaminated areas may be small and thus would not support populations large enough for statistically valid sampling, (2) the site may not be accessible because of human health and safety concerns, and (3) target species may be protected by law (e.g., bald eagles, state-listed endangered plant species). Preliminary

data obtained from site visits and results of previous studies (such as at other operable units on the site or publications from other similar sites) will serve to guide the DOE ERPM and project ecologists in determining relevant ecological data to be collected. A determination should be made on the appropriateness of concentrating mainly on the sampling of target species and populations in the field or also using surrogate species in bioassay tests under laboratory conditions (EPA 1989c). Use of surrogate species is often warranted when information is needed on potential for bioaccumulation of a contaminant or the target species is state or federally protected. Also, when a literature search indicates essentially no data on toxicity for target species being evaluated, laboratory toxicity measurements may be necessary on taxonomically similar species. Early in the planning process, ecologists should identify species or populations warranting collection of qualitative versus quantitative data. Familiarity with the species being sampled will guide ecologists in selecting appropriate statistical tools to demonstrate any effects from contaminant exposure. Natural variability in the parameters being measured must be acknowledged when attempting to show a cause-effect relationship between exposure dose and response. Specific parameters for study should be defined on the basis of assessment and measurement endpoints identified during site characterization, preliminary evaluation of field samples, and/or laboratory testing of sensitive or surrogate species. Ecological input from federal and state agencies, public interest groups, and interested individuals can provide valuable information on the societal value and biological importance of target species or communities.

Statistical Considerations

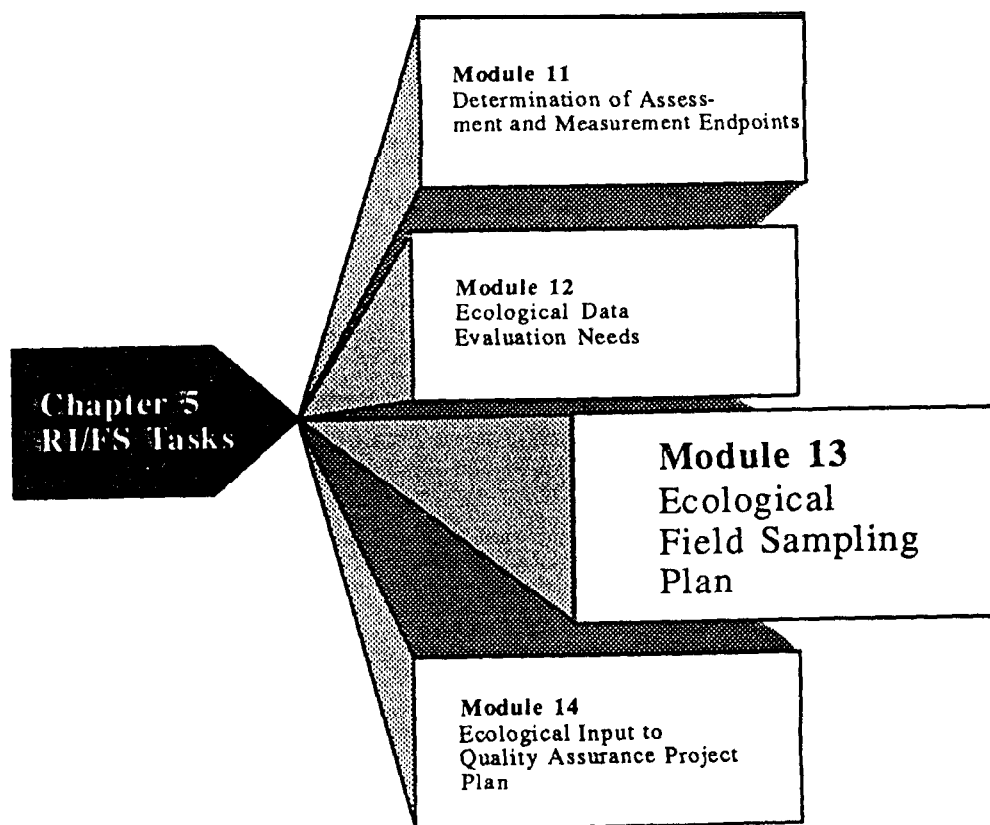
It is necessary to know the types of data analyses anticipated for evaluating site ecological descriptive information and laboratory test results before the outset of data collection. Some important issues related to data evaluation are (1) the use of statistical versus non-statistical tests, (2) the appropriateness of using hypothesis testing, (3) the applicability of using random sampling techniques, and (4) the sample size.

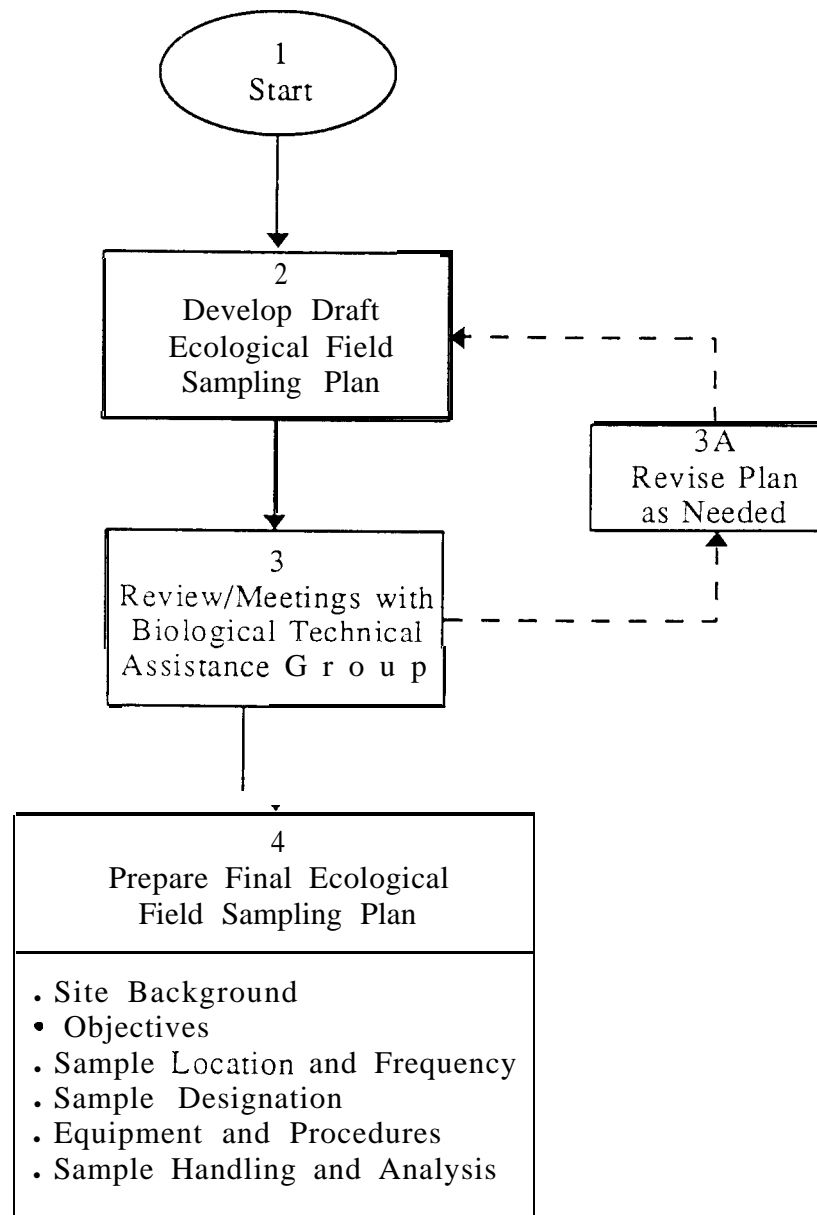
- Step 2a, 2b** Laboratory and in situ bioassay tests using surrogate species may be necessary for CERCLA sites where time and cost constraints preclude conducting extensive field sampling on all possible receptor species. Generally, the scientific literature is adequate for determining the types of data analyses best suited for surrogate species subjected to hazardous wastes in the laboratory or controlled field conditions. Examples of commonly used surrogate species include earthworms, fathead minnows, lettuce, *Daphnia*, and *Hyallela*. The BTAGs can provide input on the selection of appropriate surrogate species and bioassay tests (see **Appendix A, Section k4.1.4**).
- Step 3, 3a** In some cases, reference areas can be used in the ecological assessment for comparison with the contaminated waste site (Suter 1993). When a reference area is being selected, consideration should be given to a site with similar physical properties such as soil type, slope, aspect, and moisture conditions for a terrestrial ecosystem and parameters such as flow rates, substrate type, water depth, temperature, and chemistry for an aquatic ecosystem (see **Appendix A, Section k4.1.2**).
- Step 4** The ecological work plan should discuss the methods of evaluating data obtained during field sampling and laboratory testing. Several references provide guidance on ecological data evaluation methods and toxicity testing methodologies appropriate for hazardous waste sites: Cochran (1977); EPA (1989b, 1991c); Gilbert (1987); Green (1979). A rationale for selecting specific statistical tests should be included in the plan (see **Appendix B, Section B.7**).

References

- Cochran, W.G., 1977. *Sampling Techniques*. 3rd ed. John Wiley and Sons, Inc., New York.
- Gilbert, R.O., 1987. *Statistical Methods for Environmental Pollution Monitoring*. Van Nostrand Reinhold, New York.
- Green, R.H., 1979. *Sampling Design and Statistical Methods for Environmental Biologists*. John Wiley and Sons, Inc., New York.
- EPA, 1989b. *Ecological Assessment of Hazardous Waste Sites: A Field and Laboratory Reference*, report PB89-205967, U.S. Environmental Protection Agency, Washington, D.C.
- EPA, 1989c. *Risk Assessment Guidance for Superfund — Vol. II, Environmental Evaluation Manual*, report EPA/540/89/001; U.S. Environmental Protection Agency, Washington, D.C..
- EPA, 1991c. *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms*, report EPA/600/4-90/027, U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Cincinnati, Ohio.
- Suter, G.W., II, 1993. *Ecological Risk Assessment*. Lewis Publishers, Chelsea, Mich.

MODULE 13:
ECOLOGICAL FIELD SAMPLING PLAN



Module 13: Ecological Field Sampling Plan

MODULE 13: ECOLOGICAL FIELD SAMPLING PLAN

Step 1 Start.

Step 2 The planning stage of the ecological assessment process culminates in the preparation of the sampling and analysis plan (SAP), which consists of the quality assurance project plan (see Module 14) and the field sampling plan (EPA 1989c). EPA guidance on CERCLA RIs and FSs should be reviewed before the ecological component of a field sampling plan is developed. A strong knowledge of the RI/FS work plan will provide ecologists with a good understanding of how ecological tasks described in the ecological work plan fit with tasks in other technical areas and will also help minimize the collection of duplicative data.

The field sampling plan provides guidance on all field work by detailing all of the sampling and data collection methods necessary to conduct the ecological assessment. The field sampling plan is to be prepared before field work begins, but can be amended or revised during the field investigation process.

The RI/FS work plan outline is adapted to incorporate the unique conditions of the site being evaluated. The EPA allows for flexibility in the field sampling plan format and content. (An annotated table of contents for an ecological field sampling plan is provided in **Appendix B.**)

Step 3, 3a Meetings with the BTAG and others familiar with ecological resources of the area will expedite the review process necessary to establish the scope and content of the field sampling plan.

Step 4 The ecological field sampling plan should include the six major components depicted in Step 4 of the module diagram. Selection of equipment and sampling procedures will require input from various groups, such as state and federal agency ecologists and university researchers familiar with the ecological resources being evaluated. This interaction will ensure that state-of-the-art procedures are used for sample collection and subsequent analyses of samples. The number, size, and location of samples needed to meet sampling objectives are often controversial points between ecologists and project engineers. The DOE ERPM should contact the BTAG to obtain guidance on resolving such controversies. Ultimately, the DOE ERPM must make the final decision on sampling methodology questions. Inadequate sample size may invalidate any data collected, possibly resulting in additional sampling at a greater cost. Caution is warranted in preparing the field sampling plan to ensure that ecological data collected will also support the human health risk assessment. This approach will save both money and time in the overall RI/FS investigation of the CERCLA site.

Ecologists should interact with the BTAG in developing the field sampling plans to ensure that adequate data are collected for subsequent ecological risk assessment determinations (EPA 1988a, 1989d).

The ecological field sampling plan should be summarized in the body of the ecological work plan and included in its entirety as an appendix to the work plan.

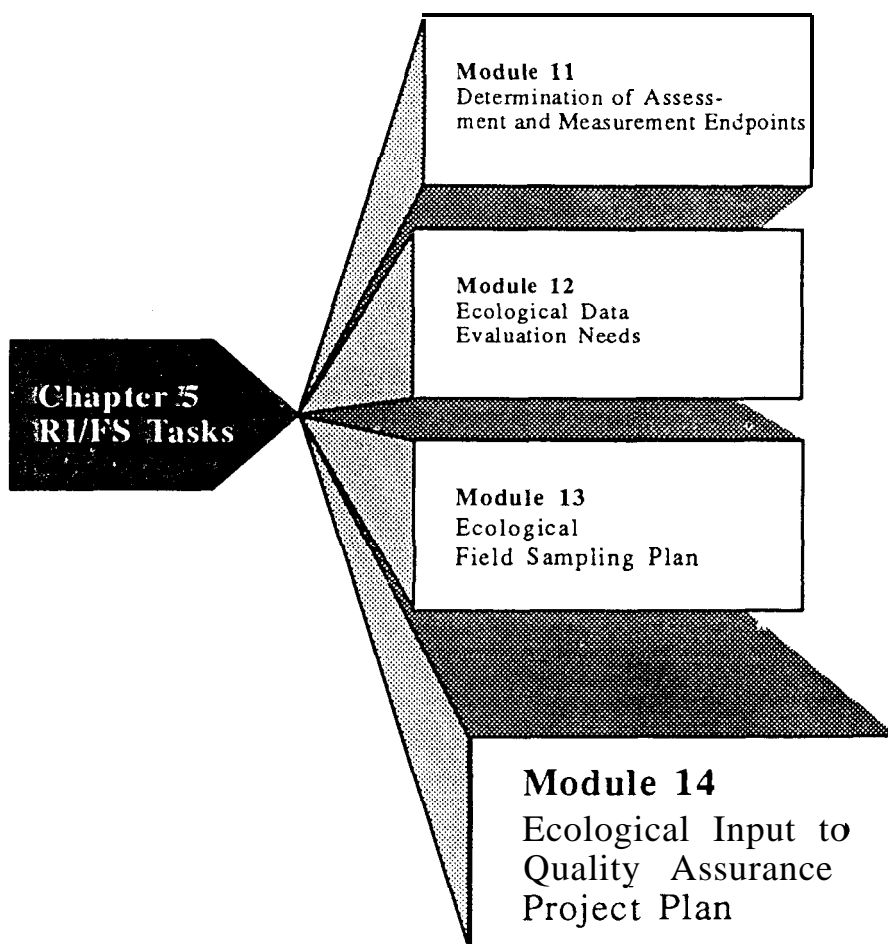
References

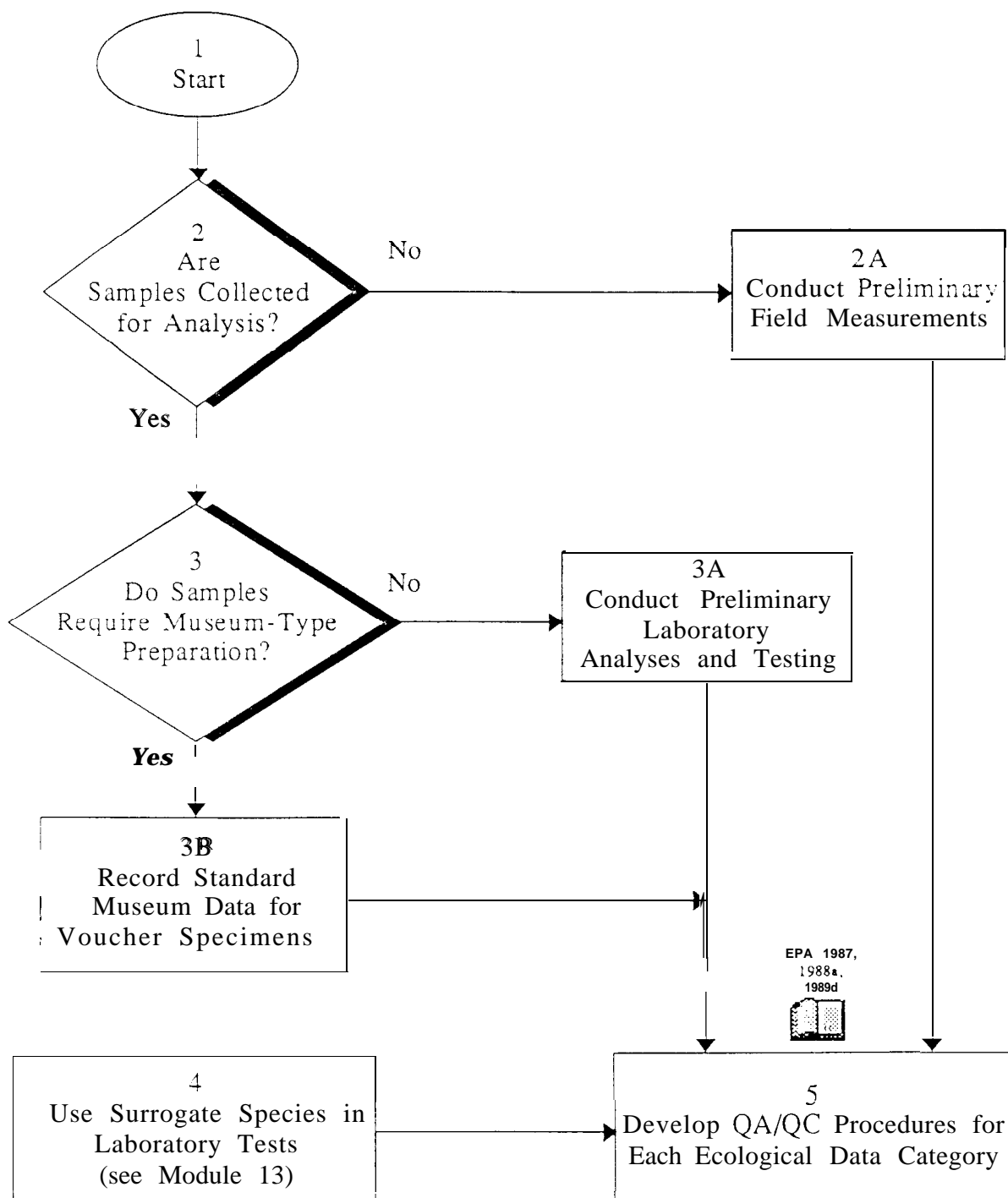
EPA, 1988a. *Guidance **for** Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*, report EPA/540/G-89/004, OSWER Directive 9335.3-01, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989c. *Risk Assessment Guidance **for** Superfund — Vol. II, Environmental Evaluation Manual*, report EPA/540/89/001, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989d. *Rapid Bioassessment Protocols **for** Use in Streams and Rivers: Benthic Macroinvertebrates and Fish*, report EPA/444/4-89-001, J.A. Plafkin (ed.), U.S. Environmental Protection Agency, Washington, D.C.

MODULE 14:
ECOLOGICAL INPUT TO QUALITY
ASSURANCE PROJECT PLAN



Module 14: Ecological Input to Quality Assurance Project Plan

MODULE 14: ECOLOGICAL INPUT TO QUALITY ASSURANCE PROJECT PLAN

Step 1 Start.

Step 2, 2a Guidance on contents of a quality assurance project plan (QAPP) has been prepared by the EPA (1987, 1988a). Formal quality assurance and quality control (QA/QC) procedures exist for some aspects of an ecological assessment (e.g., toxicity testing for aquatic species) but are less well defined for sampling of vegetation and terrestrial vertebrate groups. Some preliminary field measurements are often helpful in defining an adequate sample for statistical analyses. The BTAG members can provide input on good QA/QC procedures based on professional experience with other CERCLA sites. Also, the BTAG coordinator from the EPA should be able to provide examples of approved QAPPs for previous projects. (A list of the EPA Regional BTAG coordinators is provided in **Appendix E**.)

Laboratory toxicity tests must consider QA/QC procedures for (1) sampling and handling hazardous wastes; (2) sources and culturing of test organisms; (3) instrument calibration and testing; (4) use of reference toxicants, adequate controls, and exposure replications; (5) record keeping; and (6) data evaluation.

An overview of EPA QA/QC requirements for a Super-fund site is contained in Chapter 5 of the Risk Assessment Guidance for Superfund Volume II Environmental Evaluation Manual (RAGS II) (EPA 1989c). (An annotated table of contents for an ecological QAPP is provided in **Appendix C**.)

QAPP Elements

Elements of a QAPP typically include: (1) introduction (purpose and scope of QAPP), (2) project description, (3) QA/QC responsibility delineation, (4) QA/QC data quality objectives, (5) sample collection and custody, (6) sample analysis, (7) system controls, (8) preventive maintenance, (9) record keeping, (10) audits, (11) corrective actions, and (12) quality control reports.

Step 3,3a,3b A distinction between ecological data to be collected in the field versus laboratory data from toxicity testing should be made early in developing the ecological field sampling plan. Samples may be needed to document occurrence of the species in the area. Preliminary laboratory testing will help define (1) range of variation in test result values and (2) QA/QC process relative to the number and types of tests or analyses conducted. Standard museum data records and preservation techniques best suited for the species collected should be consistently applied for the various biotic communities

sampled. Laboratory testing and chemical analyses will require QA/QC considerations of labeling, chain-of-custody record keeping, and spot checking of analyses.

Step 4 Surrogate species, rather than organisms collected from the site, may be used for laboratory testing. Appropriate procedures should be defined to ensure the quality control of data collected.

Step 5 A QAPP should include procedures to be followed in the collection of ecological, physiological, and behavioral data. Organism tests and tissue analyses in the laboratory should be clearly defined to ensure that statistically valid tests are being conducted. The following text from RAGS II provides guidance on the function and specific requirements for measurement variables:

The QAPP serves two important functions. First, it seeks to ensure that as much as possible is done at the beginning of a study to achieve the QA objectives for the data. Second, it allows for analysis of the study to determine what improvements can be made if QA objectives are not met. The plan cannot guarantee results, but it requires the analyst to justify a particular approach before proceeding.

For each major measurement variable, the QAPP must state specific data quality objectives. This is usually accomplished by preparing a table listing the variable, the sampling method, the measurement method, the experimental conditions, the target precision (measured in relative standard deviation), the target accuracy (measured in acceptable relative deviation from the true value), and completeness (measured in terms of percent coverage).

A key aspect to obtaining ecological data suitable for statistical analysis involves a clear definition of target precision and target accuracy. Gilbert (1987) provides valuable background information on these concepts, with examples from case studies of contaminated sites. Statistical tests must be clearly defined before data are collected and must be included in the QAPP for each ecological data set. This procedure will avoid the collection of extraneous information and assure that adequate samples are taken for the statistical tests. The QAPP should be prepared following EPA guidance for content and format (EPA 1988a). It is not necessary to include a site description in the QAPP if the description is contained in the ecological field sampling plan.

References

EPA, 1987. *A Compendium of Superfund Field Operations Methods*, report EPA/540/P-87/001, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1988a. *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Interim Final*, report EPA/540/G-89/004, OSWER Directive 9335.3-01, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989c. *Risk Assessment Guidance for Superfund — Vol. II, Environmental Evaluation Manual*, report EPA/540/89/001, U.S. Environmental Protection Agency, Washington, D.C.

EPA, 1989d. *Rapid Bioassessment Protocols for Use in Streams and Rivers: Benthic Macro-invertebrates and Fish*, report EPA/444/4-89-001, J.A. Plafkin (ed.), U.S. Environmental Protection Agency, Washington, D.C.

Gilbert,, R.O., 1987. *Statistical Methods for Environmental Pollution Monitoring*. Van Nostrand Reinhold, New York.

